

Mission Technology Forum

# Section 12

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## Overview of the Hyperion Imaging Spectrometer



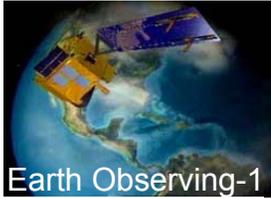
08/15-16/01

**. . . Dr. Jay Pearlman**

*[jay.pearlman@TRW.com](mailto:jay.pearlman@TRW.com)*

*Hyperion Scientist, Space & Technology Division, TRW*

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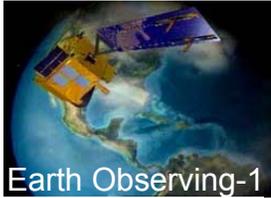
# Overview of EO-1 Hyperion



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- ◆ ***Hyperion is a successful on-orbit hyperspectral system***
- ◆ ***Hyperion design focused on land use applications; system was built in 51 weeks using existing focal planes from Lewis heritage***
- ◆ ***Hyperion has met or exceeded specifications established prior to launch***
- ◆ ***Initial analysis from EO-1 Science Validation Team indicates very good results – including mineral maps using the SWIR region above 2000nm***





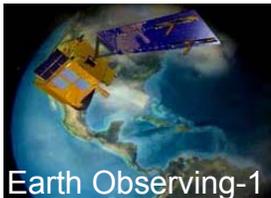
# System Design Philosophy



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- ◆ **Science-Grade Instrument**
  - *Land-cover application focus*
  - *Cross platform comparisons*
  - *Stable instrument with traceable calibration*
- ◆ **Emphasis on testing and calibration**
- ◆ **End-to-End integrated system design**
- ◆ **Establish operation capabilities early with streamlined customer interface during fabrication**
- ◆ **Use of existing long lead parts and established designs due to compressed schedule**
  - *Focal Planes, Optics, cover actuator, Lewis HSI heritage*





Earth Observing-1

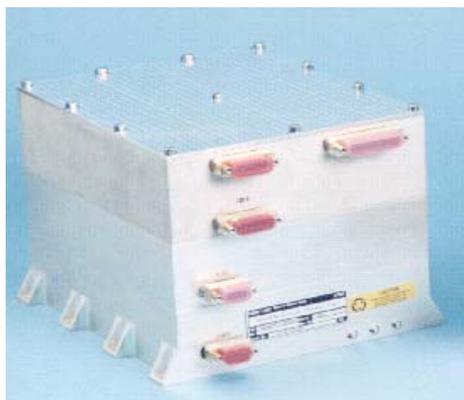
# Hyperion Design



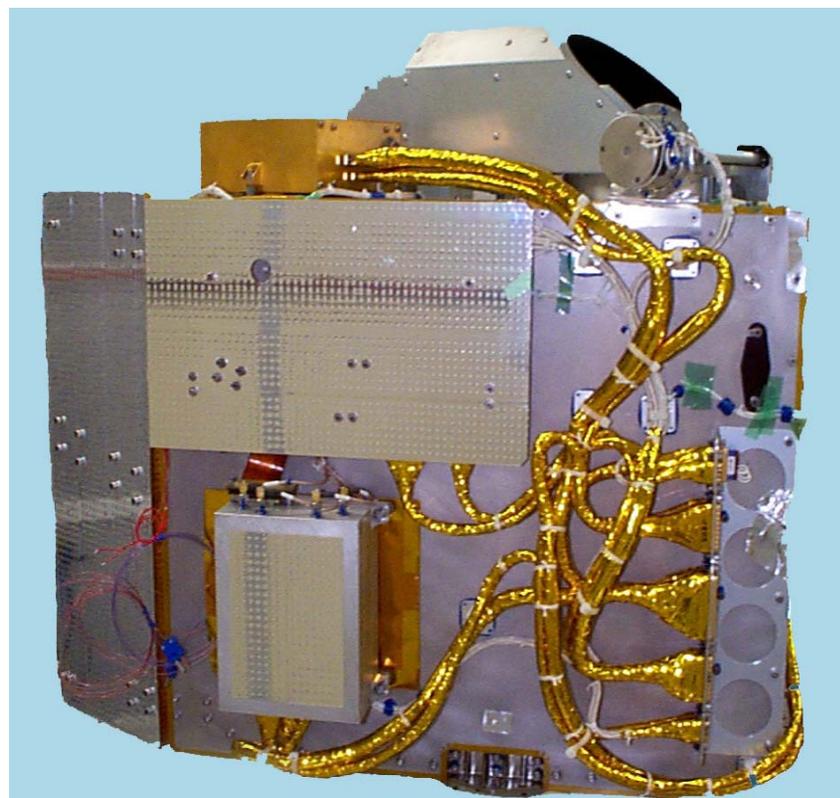
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*Hyperion  
Electronics  
Assembly  
(HEA)*



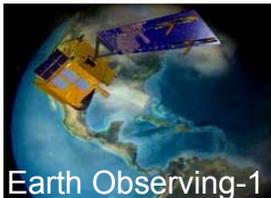
*Cryocooler  
Electronics  
Assembly  
(CEA)*



*Hyperion Sensor Assembly (HSA)*



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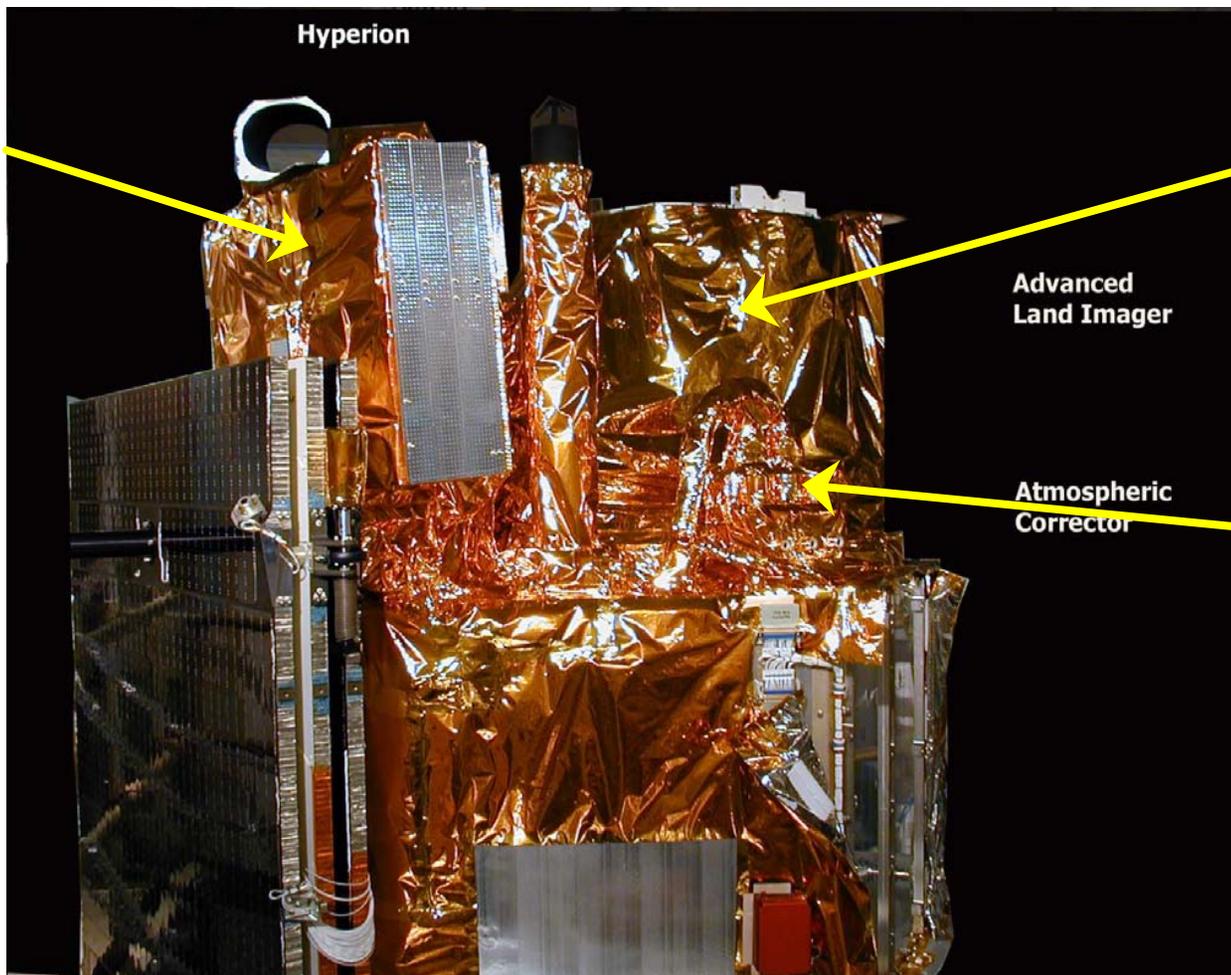


# EO-1 Spacecraft Prepared for Launch



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**HYPERION**

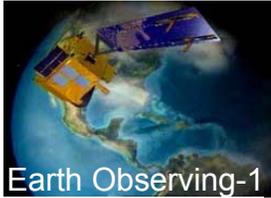


**ALI**

**LAC**



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# Hyperion Specifications

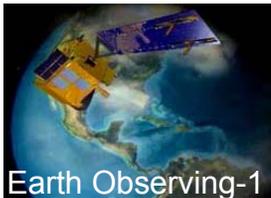


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- ◆ **Hyperion is a push-broom imager**
  - **220 10nm bands covering 400nm - 2500nm**
  - **6% absolute rad. accuracy**
  - **Swath width of 7.5 km**
  - **GSD of 30 m**
  - **IFOV of 42.4  $\mu$ radian**
  - **12-bit image data**
  - **Orbit is 705km alt (16 day repeat)**



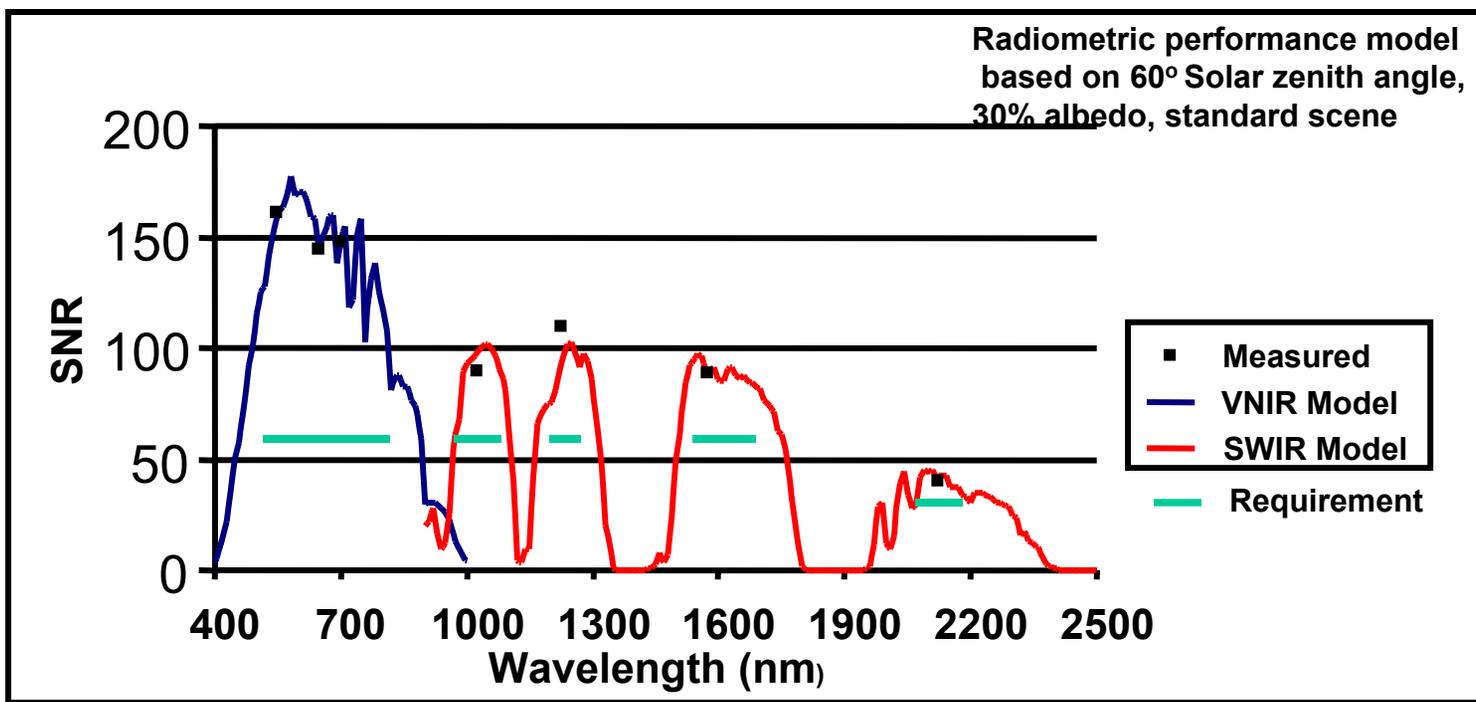
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# Signal-to-Noise Requirements & Performance



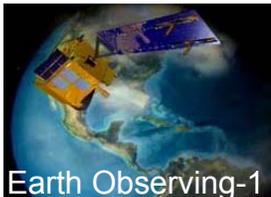
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wavelength	550 nm	650 nm	700 nm	1025 nm	1225 nm	1575 nm	2125 nm
requirement*	>60	>60	>60	>60	>60	>60	>30
pre flight (p/b tabove)	161	144	147	90	110	89	40
on orbit	192	140	140	65	96	64	38

\* System design focused on land use and emphasized blue through SWIR performance.





Earth Observing-1

# Hyperion Key Characteristics



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Characteristic	Reqm nt	Pre-launch	On-orbit
GSD (m )	30+/-1	29.88	30.38
Swath (km )	7.5	7.5	7.75
VNR MTF @ 630nm	>.2	0.22-0.28	0.23-0.27
SWIR MTF @ 1650nm	>.15	0.25-0.27	0.28
VNR X-trk Spec.Error	1.5*	2.8nm @ 655nm	2.2nm
SWIR X-trk Spec.Error	2.5	0.6nm @ 1700nm	0.58
SpatialCo-Reg:VNR	0.2	.18 @ Pix #126	**
SpatialCo-Reg:SWIR	0.2*	.21 @ Pix #131	**
Abs. Radiometry(1Sigma)	6%	<6%	3.40%
VNR SNR (550-700nm )	60	144-161	140-190
SWIR SNR (~1225nm )	60	110	96
SWIR SNR (~2125nm )	30	40	38
No.ofSpectralChannels	220	220	200 (L1)
VNR Bandwidth (nm )	10+/-1	10.19-10.21	**
SWIR Bandwidth (nm )	10+/-1	10.08-10.09	**

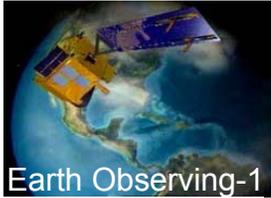
OPTICAL

RADIO-METRIC

SPECTRAL

\*Wavered; \*\* Consistent with Pre-Launch Calibration or not measured

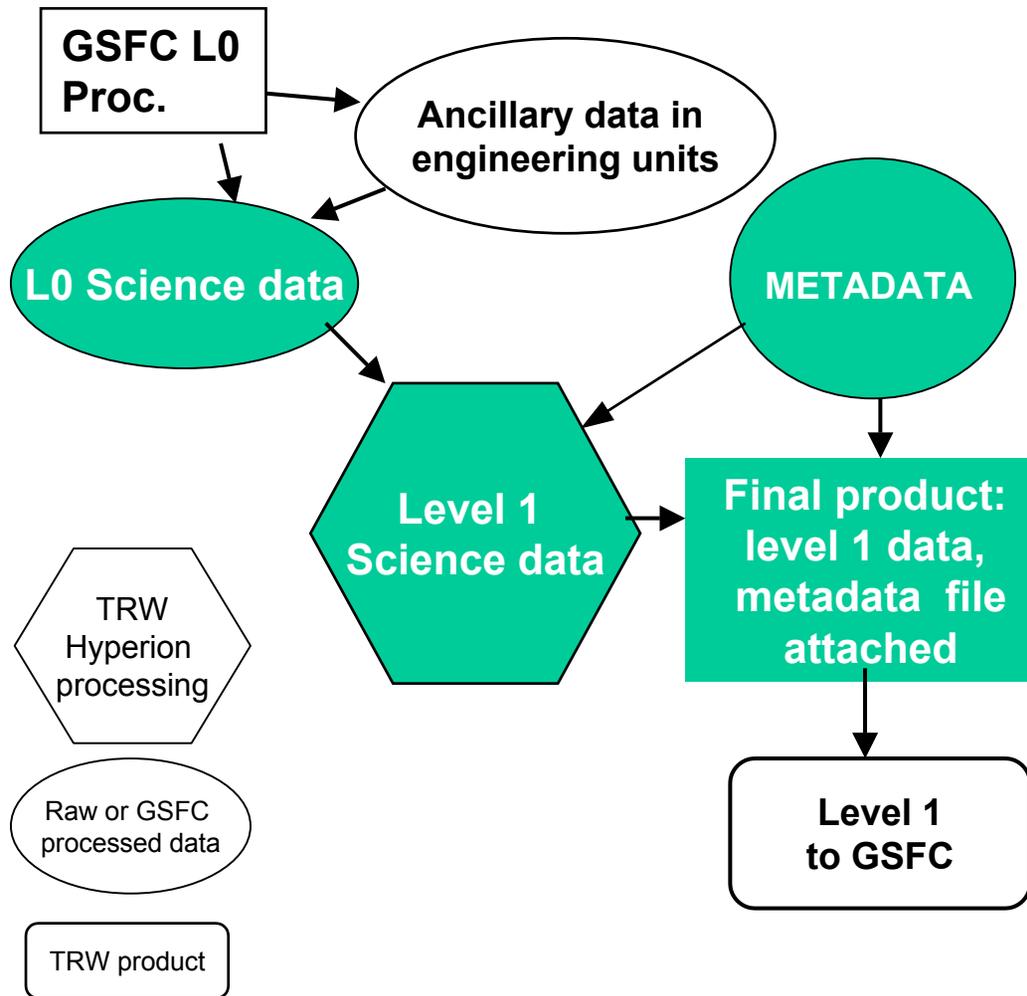




# Hyperion Data Flow



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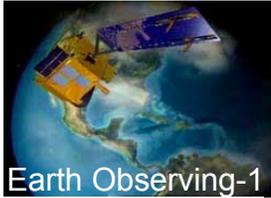


**Science Data:** Level 0 or Level 1 (radiometrically corrected) data products with VNIR and SWIR data frames combined. Includes solar, lunar calibrations, earth images, dark and light calibrations

**Metadata:** Data about the science data. Information to support higher level processing, e.g., pre-flight characterization data

**Ancillary Data:** Supporting data derived from spacecraft telemetry during image collection





# Key Technologies



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## ◆ *Instrument*

- *Pulse Tube Cryo Cooler, Curved Grating Spectrometer*
- *Fast readout electronics*
- *Combined spectral/radiometric on-board cal*

## ◆ *Pre flight calibration*

- *Doped spectralon reflector*
- *Quantum-based calibration detectors (Silicon trap detectors )*

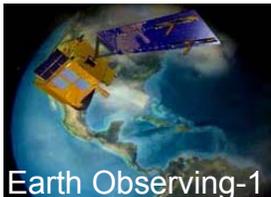
## ◆ *On-orbit calibration*

- *Lunar, stellar, planetary calibration targets*
- *Atmosphere and solar lines for spectral cal*
- *VNIR - SWIR co-registration through vicarious calibration*

## ◆ *Data Standards and processes*

## ◆ **Space-based Pushbroom Imaging Spectrometer**





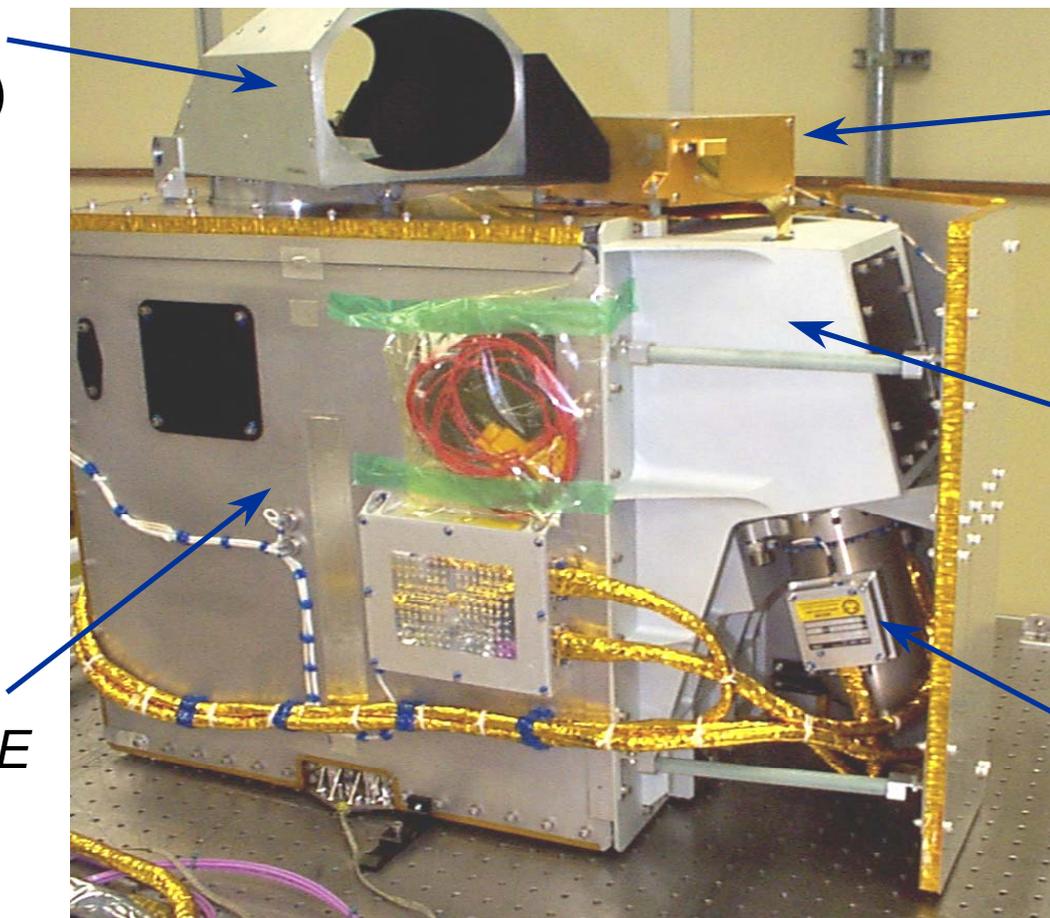
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# Hyperion Technologies



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*CALIBRATION*  
(spectral/  
pushbroom)



*DATA  
RATES*

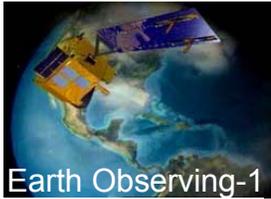
*SPECTROMETER*  
(curved grating)

*Reflecting  
TELESCOPE*

*Pulse Tube  
CRYOCOOLER*



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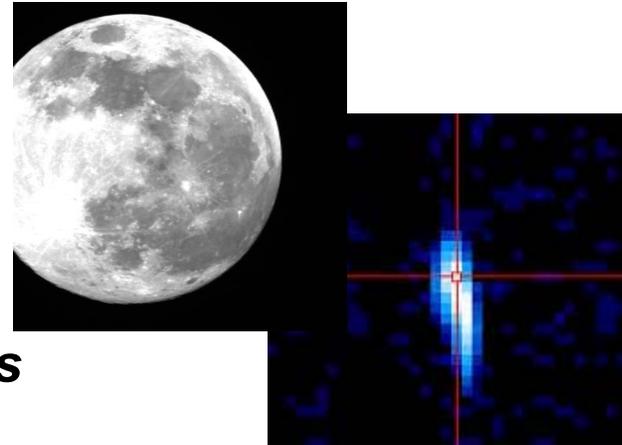
# Special Targets for Characterization



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**Searchlights  
-California**



**Sun,  
Moon  
& Venus**



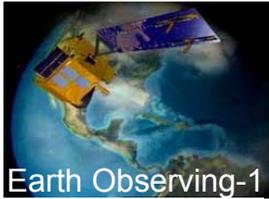
**Gas Flares  
-Moomba**



**90 deg  
Yaw**



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# Hyperion Addresses Imaging Spectrometer Capabilities Around the World

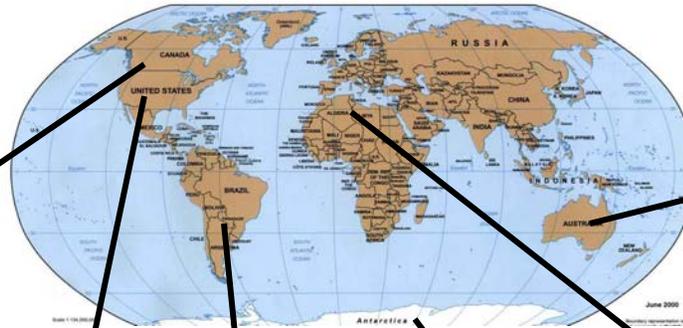


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Forests



Canada



Agriculture



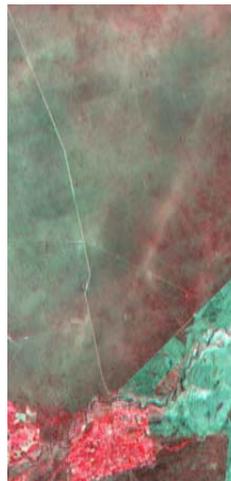
Australia

Minerals



United States

Grasslands



Argentina

Glaciers



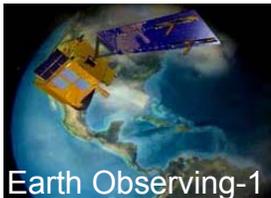
Antarctica

Deserts



Sahara





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# Work in Progress



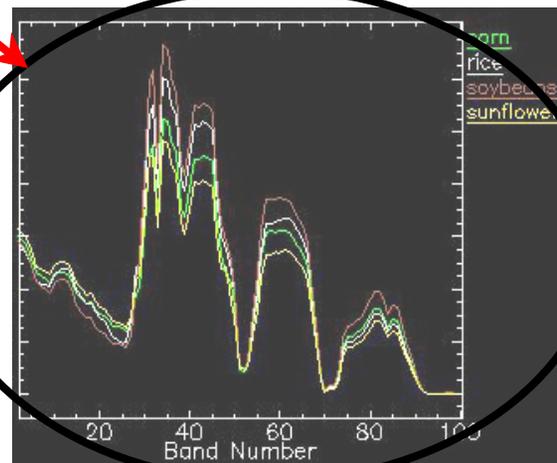
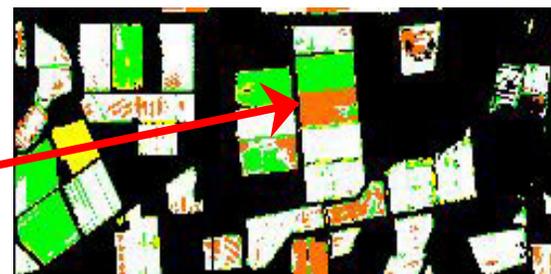
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- ◆ **Atmospheric Correction**
- ◆ **Space-Ground Data Comparisons**
- ◆ **Inter-Instrument Comparisons**
- ◆ **Science Validation**

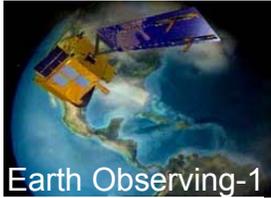


Green - Corn  
Brown - Soybean

White - Rice  
Yellow - Sunflower



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# Hyperion System Design Summary



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- ◆ ***End-to-End integrated system design***
- ◆ ***Science-grade Instrument with emphasis on calibration***
  - ***Land-cover application focus***
  - ***Cross platform comparisons***
- ◆ ***Stable instrument with traceable calibration and data processing***

***“An instrument users can rely on”***

